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(54) High gloss, low friction plastics sheet, method of production thereof, and container made from the sheet.

(57) A plastics sheet or laminate having the sheet as an outer layer has a surface of low friction and high gloss which is produced by extruding a layer of thermoplastic and pressing it while hot against the surface of a chill roller. The chill roller is highly polished and has minute randomly distributed superficial depressions therein of an average depth of about 5 microns, a depth standard deviation of less than 3 microns, an average frequency of about 3,000 per square centimeter, and an average area per depression of less than 1,000 square microns. The depressions are convex with rounded peripheries and are reproduced - as prominences - on the thermoplastic face material. The surface will have a coefficient of friction generally less than 1.0 with respect to itself, while nonetheless retaining a high gloss appearance. The sheet is useful as a protective outer layer of tubular containers e.g. toothpaste tubes.

EP 0 089 746 A2

printing and decoration on the tube.

The outer layer of a tube package is particularly critical since, in addition to protecting the printing and other layers beneath, it should have a high gloss for aesthetic appeal. The attractiveness of the complete package is particularly dependent upon the gloss of the surface of the outer layer, and, in addition, the glossiness of the outer surface affects the visual impression transmitted from the printing below the outer layer. Distortion and "fuzzing" of the printing can occur if the outer surface is dull or has a matte finish because of the random refraction of light transmitted through the outer protective layer. It has been found, however, that extremely glossy or smooth surfaced outer layers also have a very high coefficient of friction which can lead to stacking and handling problems when the tubes are in contact with one another. The high friction of the outer surface also creates a problem when the flat wall stock is drawn through a forming die to form the tubes, since the outer surface will be in dragging contact with the die.

To minimize the coefficient friction of a plastic surface, it is known to use a roughened or

chill roll having a highly polished surface interrupted by minute depressions distributed over the surface of the roller, the depressions having an average depth of about 5 microns, a standard deviation of the depth of less than 3 microns, an average area for each depression of less than 16,000 square microns, and an average frequency of depressions over the surface of the roll of approximately 3,000 per square centimeter, the depressions being substantially convex and rounded about the periphery of the depressions.

The invention comprehends a chill roll having the above-defined characteristics.

The invention also provides a plastics sheet having a surface of high gloss and low coefficient of friction, the surface being comprised of a layer of thermoplastic material with a smooth surface interrupted by randomly distributed prominences, characterised in that the prominences have an average area of less than 16,000 square microns, an average height of about 5 microns, a standard deviation of the height of the prominences about the average of less than 3 microns, and an average frequency of the prominences over the surface of the sheet of 3,000 per square centimeter, the

of several materials, to make a layered structure suitable to form a wall of a tube container. The entire laminated structure may then be shaped in a die into a tubular form with overlapping edges to be heat sealed together, the conditioned surface layer forming the outermost layer of the tube and covering any printing or decoration on the base layer to which it is coated.

The chill roll is preferably a hard surfaced roll which is first blasted with a fine grit to form minute surface depressions, of random distribution and varying depth, and is then chromium plated. The roll so formed is then highly polished to remove a substantial portion of the chromium surface of the roll until the depressions within the roll have an average depth of about 5 microns, (within a range of about 2 to 10 microns) and a standard deviation of less than about 3 microns, and having an average area of less than 16,000 square microns.

The resulting plastics product, whether it be a single layer or a multi-layer laminate, has a surface which is both high in gloss and substantially lower in coefficient of friction than is commonly observed with present high gloss tube packages.

The invention will be described now in more

Fig. 1 shows a simplified side view of apparatus 10 for forming an extruded plastic sheet and for laminating sheets together. The finished laminated product is shown for illustration as having an inner surface 11 on a preformed continuous sheet or web 12, and an outer layer of thermoplastic 13. The preformed base layer 12 is typically a composite of a barrier layer formed of a material such as metal foil which is impervious to gas and moisture, with a surface layer of plastic such as polyethylene. Such a structure is illustrative only, since common wall structures for packages such as toothpaste tubes usually have more than three layers, including layers of paper and special plastics. It is also common for the outer surface of the layer 12 to have printing and decoration thereon which is covered and protected by the outermost layer 13. The present invention resides primarily in the manner of forming and surface conditioning the outermost layer 13; the base layer or laminate on which the layer 13 is laid, illustratively shown as the single layer 12, may be formed and laminated in any desired manner.

The material forming the outer layer 13 may

through its interior. As the surface of the roller 17 contacts the hot plastic exiting from the extruder 15, the plastic drops in temperature and substantially hardens. The surface characteristics of the chill roller will thus be permanently impressed upon the surface of the plastic. To achieve the high gloss desired on the outside surface of container tubes such as those used to carry toothpaste, it has been common to use a highly polished (commonly called a mirror finish), chrome plated chill roller. Tubes formed from plastic treated with such a chill roller typically have a gloss level between 60 and 80 units (as measured with a Hunter gloss meter, at TAPPI 20^{0} angle) and a coefficient of friction of 6 to 8 units (as measured face-to-face on a Kayeness friction tester). The gloss and clarity of the surface obtained with such a chill roller is satasifactory, but the high level of friction presents difficulties in forming the tubes and also in handling the tubes during packing and shipping.

One approach to the problem of producing extruded plastic sheets having satisfactory gloss and friction characteristics is to use a polished chill roll which has minute surface depressions.

peripheries of the prominences is revealed from an examination of Fig. 3, since the depressions in the roll have jagged peripheries. The polyethylene surface was found to have a satisfactory face-to-face coefficient of friction, in the range of 0.3 to 0.5, but the measured gloss was in the range of 25 to 40 (Gardner gloss guard, 45° angle) compared to a gloss measurement of about 50 (Gardner gloss guard, 45° angle) for standard polyethylene films produced with a smooth chill roller. When such a chill roller is used to produce the outer layer of a laminate in which such transparent outer layer covers printing, a slight reduction of the clarity of the printed matter is observed. The many jagged protrusions observed about the peripheries of the prominences on the plastic sheets of Figs. 4 and 5 may tend to diffuse or scatter light from the surface, thus reducing gloss.

A photomicrograph at a magnification of 50X of the surface of a chill roller used to produce plastic film in accordance with the present invention is shown in Fig. 6. The roller of Fig. 6 is produced by polishing down a substantial portion of the chromium plated surface of a

It is readily seen that the prominences formed on the surface of the sheet are substantially convex and are regular around their peripheries with relatively few jutting, jagged portions extending away from the prominences. A multilayer sheet having a low density polyethylene outer layer 13 formed in such a manner was found to have a coefficient of friction, as tested face-to-face on a Kayeness Friction Tester, in the range of 0.1 to 1.0, over a selection of several samples formed in accordance with the invention. The gloss was found to be in the range of 60 to 70 units, at a TAPPI 20° angle. The heights of the prominences, which correspond to the depths of the depressions on the chill roll, lie almost entirely in the range of 2 to 10 microns, with a standard deviation of less than 3 microns (generally ranging from 2 to 3 microns), about the average prominence height of 5 microns. The area occupied by individual prominences averages less than 16,000 square microns.

A multilayer laminate suitable for use as a tube container wall was produced in accordance with the process shown in Fig. 1. The layer 13 was formed of a coextrusion of low density

Claims:

1. A method of producing a plastics sheet having a surface with both high gloss and low coefficient of friction characteristics, wherein a thermoplastic material is extruded to form a heated thermoplastic layer, characterised in that the said layer is pressed while still in a softened state with a chill roll which is maintained at a temperature at which it will cool and harden the surface of the layer contacted thereby, the chill roll having a highly polished surface interrupted by minute depressions distributed over the surface of the roller, the depressions having an average depth of about 5 microns, a standard deviation of the depth of less than 3 microns, an average area for each depression of less than 16,000 square microns, and an average frequency of depressions over the surface of the roll of approximately 3,000 per square centimeter, the depressions being substantially convex and rounded about the periphery of the depressions.

2. The method according to claim 1 further characterised by the additional steps of forming a base layer of at least one selected material, and placing the surface of the thermoplastic layer

3,000 per square centimeter, the prominances being substantially convex and rounded about their peripheries.

5. The plastics sheet according to claim 4 characterised in that the thermoplastic material is polyethylene and that the surface of the sheet has a face-to-face coefficient of friction of 1.0 or less and has a gloss, TAPPI 20^{o} angle, from 60 to 70 units.

6. The plastics sheet according to claim 4 or claim 5, characterised in that the thermoplastic surface is the outer overcoat surface of a printed and/or decorated substrate, the thermoplastic surface being transparent.

7. A container having a layer as or near the outermost layer comprising a plastics material having a smooth surface interrupted by randomly distributed prominences characterised in that the prominances have an average area of less than 16,000 square microns, an average height of about 5 microns, a standard deviation of the height of the prominences about the average of less than 3 microns, and an average frequency of the prominences over the surface of about 3,000 per square centimeter, the prominences being substantially convex and rounded about their peripheries.

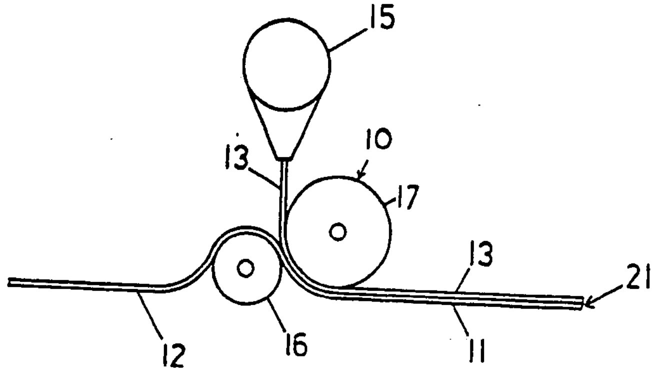

FIG. 1

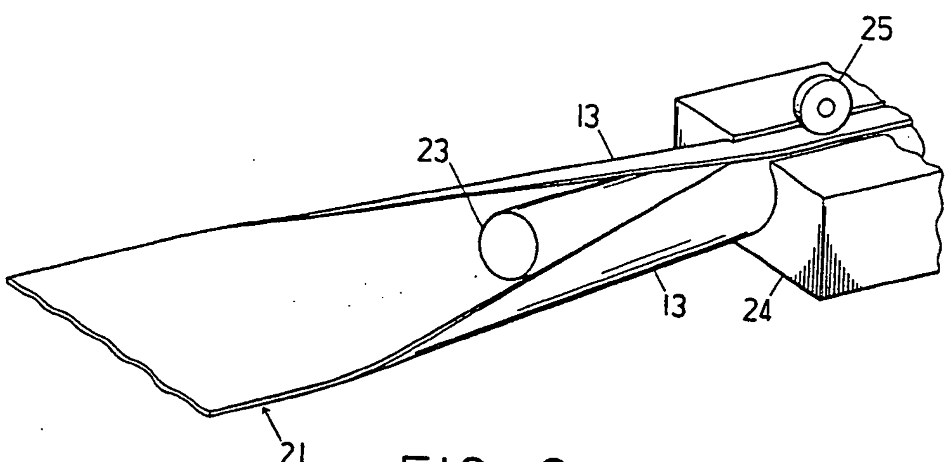

FIG. 2

FIG. 6

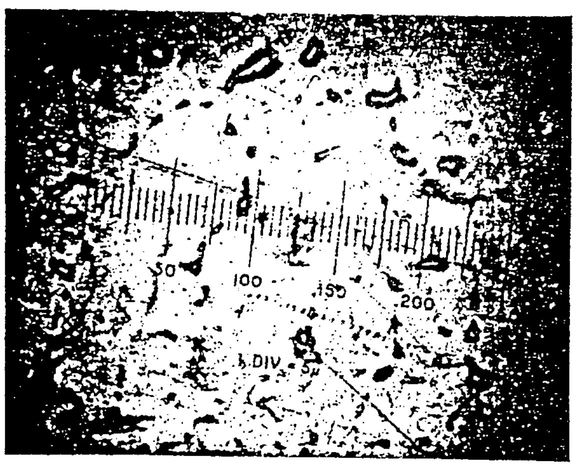

FIG. 7

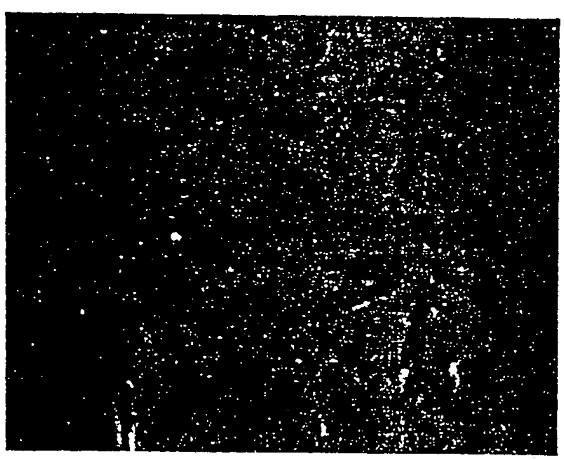

FIG. 8